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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6300
Specification A

MAS4/W Statistics 4

Mark Scheme

2005 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Key to Mark Scheme

M	mark is for	method
m	mark is dependent on one or more M marks and is for	method
A	mark is dependent on M or m marks and is for	accuracy
B	mark is independent of M or m marks and is for	accuracy
E	mark is for	explanation
√or ft or F		follow through from previous incorrect result
CAO		correct answer only
AWFW		anything which falls within
AWRT		anything which rounds to
AG		answer given
SC		special case
OE		or equivalent
A2,1		2 or 1 (or 0) accuracy marks
–*x* EE		deduct *x* marks for each error
NMS		no method shown
PI		possibly implied
SCA		substantially correct approach
c		candidate
sf		significant figure(s)
dp		decimal place(s)

Abbreviations used in Marking

MC – *x*	deducted *x* marks for mis-copy
MR – *x*	deducted *x* marks for mis-read
ISW	ignored subsequent working
BOD	given benefit of doubt
WR	work replaced by candidate
FB	formulae book

Application of Mark Scheme

No method shown:	
Correct answer without working	mark as in scheme
Incorrect answer without working	zero marks unless specified otherwise
More than one method / choice of solution:	
2 or more complete attempts, neither/none crossed out	mark both/all fully and award the mean mark rounded down
1 complete and 1 partial attempt, neither crossed out	award credit for the complete solution only
Crossed out work	do not mark unless it has not been replaced
Alternative solution using a correct or partially correct method	award method and accuracy marks as appropriate

MAS4/W

Q	Solution	Marks	Total	Comments
1(a)	$S_{xx} = 49277 - \frac{689^2}{10} = 1804.9$	B1		
	$S_{yy} = 58679 - \frac{759^2}{10} = 1070.9$	B1		
	$S_{xy} = 53052 - \frac{689 \times 759}{10} = 756.9$	B1		
	$r = \frac{756.9}{\sqrt{1804.9 \times 1070.9}} = 0.544$	M1 A1	5	
(b)	Low positive correlation; possibly not significant	E1	1	
	Total		**6**	
2	$\frac{82}{144} \pm 1.96\sqrt{\frac{\frac{41}{72} \times \frac{31}{72}}{144}}$	B1 M1 A1		*z* value
	(0.489, 0.650)	A1	4	AWRT
	Total		**4**	
3(a)(i)				

Rank for	Rank against	d^2
1	10	81
3	5	4
6	6.5	0.25
2	9	49
4.5	4	0.25
4.5	8	12.25
7.5	6.5	1
7.5	3	20.25
10	2	64
9	1	64
		296

		M1	ranking
		A1	for
		A1	against
		m1	$\sum d^2$
		A1	
	$r_s = 1 - \frac{6 \times 296}{10 \times 99} = -0.794$	m1 A1	accept *r* on ranks AWRT $r = -0.810$
(ii)	Information is lost by ranking	E1	1
(b)	$H_0 : \rho_s = 0 \quad H_1 : \rho_s < 0$	B1	both
	c.v.(1%) = – 0.7333	B1	allow 0.7333
	– 0.794 < – 0.7333	m1	allow 0.794 > 0.7333
	Reject H_0		
	So implying $\rho_s < 0$	A1	4
	Total		**12**

MAS4/W (cont)

Q	Solution	Marks	Total	Comments
4(a)	$H_0: p = 0.2 \quad H_1: p > 0.2$	B1		both
	$X \sim$ Bin (50, 0.2)	M1		allow $X \sim$ N (10, 8) or $p \sim N(0.2, 0.0032)$
	$P(X \geq 15) = 1 - 0.9393 = 0.0607$	A1		$Z_{calc} = 1.59$ (= 1.768 without continuity correction)
	$0.0607 > 0.05 \Rightarrow$ retain H_0			
	No evidence of improvement at the 5% level	A1√	4	$Z_{crit} = 1.6449$
(b)	$P(X \leq 17) = 0.9937 \Rightarrow 18$ is the least	M1		$10 + 2.3263\sqrt{8}$
	value to show improvement at 1% level	A1	2	$= 16.579 \Rightarrow 17$
	Total		**6**	
5(a)	$y = cd^x$			
	$\Rightarrow \ln y = \ln c + x \ln d$	M1		
	$\Rightarrow y = mx + c$	A1	2	
(b)	$S_{xy} = 61.107 - \frac{26.492 \times 22}{10} = 2.8246$	M1		
	$S_{xx} = 72 - \frac{22^2}{10} = 23.6$			**full data:**
	$b = \frac{2.8246}{23.6} = 0.11968\ldots$	A1		0.11967…
	$\ln \bar{y} = 2.6492, \quad \bar{x} = 2.2$	B1		both
	$a = 2.6492 - 0.11968\ldots \times 2.2$	M1		
	$= 2.38588\ldots$			2.38595…
	$\ln y = 2.39 + 0.120\,x$	A1	5	accept 0.12
(c)	$\ln c = 2.385\ldots \Rightarrow c = 10.9$	M1		anti logging
		A1		AWRT
	$\ln d = 0.11968 \Rightarrow d = 1.13$	A1	3	
(d)	$y = cd^x$	M1		14.66
	$= 14.7$	A1	2	accept AWRT 14.7 or 14.8 CSO
				$(11 \times 1.1^{2.5} = 14.6$ is M1A0)
	Total		**12**	

MAS4/W (cont)

Q	Solution	Marks	Total	Comments
6	$H_0: P_S - P_A = 0 \qquad H_1: P_S - P_A \neq 0$	B1		both
	$P_S = \frac{91}{250} = 0.364 \qquad P_A = \frac{73}{250} = 0.292$	B1		both (may be implied by working)
	$Z_{calc} = \frac{0.072 - 0}{\sqrt{\frac{0.364 \times 0.636}{250} + \frac{0.292 \times 0.708}{250}}}$	M1		variance
		M1		accept pooling
	$= 1.7196$	A1		$\hat{p} = 0.328$
	$Z_{crit} = \pm 1.96$	B1		$Z_{calc} = 1.7146$
	$\Rightarrow$ Retain H_0			
	Support is the same in both faculties at 5% level	A1√	7	
	Total		**7**	
7(a)	$E\left(\frac{X-b}{a}\right) = \frac{1}{a}E(X-b) = \frac{1}{a}E(X) - \frac{b}{a}$	M1		
	$= \frac{1}{a}(a\lambda + b) - \frac{b}{a} = \lambda$	M1 A1	3	
(b)(i)	$E(X) = \frac{2}{9}\int_{\lambda}^{\lambda+3} (\lambda+3)x - x^2 \, dx$	M1		LNR
	$= \frac{2}{9}\left[(\lambda+3)\frac{x^2}{2} - \frac{x^3}{3}\right]_{\lambda}^{\lambda+3}$	A1		
	$= \frac{2}{9}\left\{\frac{[\lambda+3]^3}{2} - \frac{[\lambda+3]^3}{3} - \left[\frac{(\lambda+3)}{2}\lambda^2 - \frac{\lambda^3}{3}\right]\right\}$	A1		inserting limits
	$= \frac{2}{9}\left\{\frac{(\lambda+3)^3}{6} - \frac{3\lambda^3 + 9\lambda^2 - 2\lambda^3}{6}\right\}$	m1		common denominator
	$= \frac{2}{9}\left\{\frac{\lambda^3 + 9\lambda^2 + 27\lambda + 27 - \lambda^3 - 9\lambda^2}{6}\right\}$	A1		
	$= \lambda + 1$	A1		
	Unbiased estimator is $X - 1$	A1	7	or $\overline{X} - 1$
(ii)	$\overline{X} = \frac{30}{5} = 6$	B1		
	$\hat{\lambda} = 6 - 1 = 5$	M1		use of any value for X
		A1√	3	ft on $\overline{X}$ only
	Total		**13**	
	TOTAL		**60**	